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FRAMEWORK FOR DEVELOPING INTELLECTUAL SKILLS USING COLLABORATIVE LEARNING TOOLS: THE EXPERTS' CONSENSUS

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ABSTRACT

Background and Purpose: Students in higher education need intellectual skills for critical thinking, problem-solving and creating new knowledge. Social interactions during collaborative learning (CL) encourage these cognitive processes. However, instructors lack the skill to develop intellectual skills using appropriate pedagogy and CL tools. Hence, this study seeks to develop a framework for developing intellectual skills.

Methodology: The Fuzzy Delphi Method (FDM) was employed to identify and determine consensus on elements to teach intellectual skills among 16 panel of experts in educational technology and continuous professional development. In the first round, semi-structured interviews were conducted among four experts and the themes emerging from the interviews were used to develop the FDM questionnaire. The questionnaire was used in the second round of the FDM to determine consensus among the experts based on calculations of the defuzzification value.

Findings: The consensus among the experts is that resources for teaching intellectual skills are videos, interactive slides, animation/graphics and quizzes while the corresponding assessments are student-generated contents (i.e videos, infographic posters, interactive slides and designed products).

Contribution: The framework with the instructional strategies, resources and assessment provides a guideline for instructors to plan instruction for developing intellectual skills and generating new knowledge.

Keywords: intellectual skills, collaborative learning, collaborative learning tools, Fuzzy Delphi, Merrill's First Principles of Instruction

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1.0 INTRODUCTION

Graduates from higher education institutions (HEI) are expected to have intellectual skills: critical thinking skills for thinking analytically, synthesizing, evaluating and cognitive strategies for creating new knowledge and solving problems (DeWitt & Koh, 2020; Dick, Carey, & Carey, 2014). This enables graduates to be adaptive, prepared for their future work and develop lifelong learning skills. Hence, instructors in HEIs need to ensure graduates acquire more than declarative knowledge (facts, concepts, principles, procedures and processes) but who acquire skills for generating new knowledge (Biasutti & El-Deghaidy, 2012; DeWitt, Alias, & Siraj, 2015; DeWitt & Koh, 2020).

However, instructional strategies among instructors in HEI are usually limited to basic activities such as drill and practice, using internet search engines for finding information, using the computer as a reward activity, designing worksheets and assessments, downloading videos for students to view or transferring information during lectures using power-point slides; activities which do not develop intellectual skills nor promote active learning (Jimoyiannis, 2010; Miner, Mallow, Theeke, & Barnes, 2015; Ponce, Mayer, López, & Loyola, 2018). Instructors seem to employ traditional didactic pedagogy when using technology (Picciano, 2015; Zanjani, Edwards, Nykvist, & Geva, 2017).

Teaching with technology needs to integrate suitable instructional strategies to achieve the skills or tasks students require (Jen, Yeh, Hsu, Wu, & Chen, 2016; Spector, 2016). Hence, in this study the framework for designing a learning environment for developing intellectual skills is investigated. A collaborative technology-enhanced learning environment with a suitable instructional strategy may enhance intellectual skills. This is because cognitive processes during social interactions in collaborative learning (CL) on tools such as wikis and virtual walls, when applied appropriately, has developed intellectual skills (Adeyinka, Okemute, & Tella, 2018; DeWitt & Koh, 2020).

Students develop their critical thinking skills as they interact, explore their understandings, analyze and synthesize information for sharing knowledge, and construct new knowledge (Bates, 2015; DeWitt & Koh, 2020). CL tools which enable online interaction, are easily accessible on mobile devices (DeWitt & Koh, 2020; Sheriff, 2015). Hence, a CL environment with suitable tasks has the potential for developing intellectual skills (Kuo, Belland, & Kuo, 2017; Stoddart, Chan, & Liu, 2016; Vangrieken, Dochy, Raes, & Kyndt, 2015).

Instructors in HEIs have content expertise in their subject area but may lack the pedagogy and technology skills in designing CL environments (Bower, 2016; Gast, Schildkamp, & Veen, 2017; Hobbs & Tuzel, 2017). Further, they may not be aware of instructional strategies and techniques for CL and may have employed inappropriate instructional strategies for presenting knowledge and teaching skills (Seel, Lehmann, Blumschein, & Podolskiy, 2017). The rapid advancement in technology has provided access to new tools: wikis, interactive virtual walls, podcasts and new emerging collaborative platforms, which makes it difficult for instructors to keep up with the technologies and determine CL tools suitable for instruction. Hence, there is a need for more research to investigate the affordances of new tools so that instructors can be informed on use of suitable tools (Bower, 2016).

Therefore, in order to develop graduates with intellectual skills, instructors in HEI need to have the capacity to design collaborative technology-enhanced learning environments with appropriate CL tools. A framework for designing lessons to develop intellectual skills, with suggested tasks and tools, is needed. This framework would serve as a guideline for instructors to design learning tasks that promote collaboration and knowledge construction while engaging students in real-world problem-solving.

2.0 LITERATURE REVIEW

2.1 Social Constructivism

CL draws upon the theories of social constructivism which focuses on individual development through the sharing of cultural artefacts, using speech and writing to mediate in a social environment (Vygotsky, 1978). Social and cultural exchange is important as students collaborate to share information and develop their own understandings and knowledge in an authentic context. Vygotsky highlighted that learners do not learn in isolation but during interactions, firstly with others at the social level, and then secondly, with oneself, at the individual level. In this study, the development of intellectual skills involves both processes at social and individual level. During the social interactions as a group, learners collaborate to achieve the team's common goals (Johnson & Johnson, 2004). Learning occurs at the individual level as learners firstly internalize the newly acquired knowledge (DeWitt & Koh, 2020), and when their knowledge is shared, it is externalized, as multiple perspectives are compared and synthesized with interactions among peers (Vásquez-Bravo, Sanchez-Segura, Medina-Dominguez, & de Amescua, 2013). New knowledge is created through the processes of CL (Xie, 2013).

In social constructivism, cultural tools employed during the interactions enable the construction and internalization of knowledge (Vygotsky, 1978). These tools enable learners to establish their own personal meaning. Discussion forums, wikis, blogs, virtual walls and text messaging platforms, cultural tools for the learners' social and cultural exchange in CL (Huizen, Oers, & Wubbels, 2005). Interactions with these CL tools means learners need to generate their own knowledge and share with others (DeWitt & Koh, 2020). Students are able to actively build their knowledge by debating and argumentation among a community of practice (Kear, 2011). Thus, deep learning and conceptual changes may occur during the CL process.

2.2 Nature of Collaborative Learning and Tools in Higher Education

Collaborative learning (CL), a pedagogical approach for students to achieve shared goals and gain knowledge as they complete projects, solve problems and create new knowledge (Kuo et al., 2017; Stoddart et al., 2016). Hence, a mutual connection between the members of the community as they carry out the tasks with a shared mission or purpose is apparent (Vangrieken et al., 2015). CL for the acquisition of information, skills and attitudes is a product of group interactions for the creation of social experiences among learners (Fu & Hwang, 2018; Johnson & Johnson, 2004).

Collaboration involves a joint engagement between learners to solve problems in a coordinated manner, normally through face-to-face interaction, but can take place synchronously and concurrently with learning activities. However, CL can occur between groups both synchronously as well as asynchronously using appropriate technology, where the instructors and peers play an important role as moderators of the learning process.

CL tools are web-based tools that facilitate the creation of content through social interactions (Herrera-Pavo, 2020; Oliver, 2010). Many of these tools make use of mobile learning to generate new learning experiences and shared resources (Bishop & Elen, 2014). Hence, these tools allow instant access to rich and diverse information resources (Fırat & Koksal, 2017). Examples of CL tools are for content creation (blogs, wikis, podcast), social networking (Facebook, Twitter, YouTube), bookmarking (tagging and RSS feeds) and communication (instant messaging (IM) and discussion forum). In HEI, CL tools have the potential to promote effective teaching and learning but is not optimized the institutions nor the instructors (Shelton, 2017). Many education-related tasks can be done by CL tools, example, reading a text, debating online, composing web materials, developing audio and video podcasts. Hence, we should incorporate suitable CL tools to facilitate learning for students in the institutes of higher learning.

Learning in HEI should promote students' problem-solving skills and for students to apply, create and connect knowledge using higher level thinking, rather than transmission of knowledge (Dewitt et al., 2015). According to Ministry of Higher Education (MOHE) (2015), students who use technology tools for learning are self-regulated and responsible for their own learning. However, being digital natives does not ensure they have higher-order thinking. For example, many students use technology for social microblogging e.g. Facebook but now for generating new knowledge (DeWitt, Alias, Siraj, & Hutagalung, 2014). More research on CL tools is needed for instruction in higher education.

2.3 Taxonomy of Learning

Learning is the process where new information developed is transformed and evaluated to determine if it is useful (Bruner, 1960). In instructional design, the pedagogical approach and the assessments would be identified based on the type of learning in achieving the goal and the expected learning outcomes (Smith & Ragan, 2005). Hence, the tasks for learning would differ depending on the type of learning.

Learning can occur through formal means, such as schools and other institutions, or informally in our everyday lives. There are different forms of knowledge: declarative (knowledge about what), procedural (knowledge about how), strategic or tacit (knowledge about which, when, and why) (Gagné, 1985; Kraiger, Ford, & Salas, 1993).

The kind of knowledge acquired may differ according to the individual learner (e.g., composing letter with writing device and reading textbooks require different skills) (Driscoll, 2005). However, the outcomes of learning are related to the type of knowledge. Gagné (1971) was the first to propose the different types of learning comprising of the cognitive, affective, and psychomotor domains.

Gagné highlighted the need for differentiating instructional strategy and assessment according to learning domains and types of learning (Bloom, 1956; Krathwohl, Bloom, & Masia, 1964). Gagné differentiated five domains of learning: verbal information, intellectual skills, cognitive strategies, attitude, and motor skills. This aligned with Gagné's definition of "learning as a process of acquiring modification in existing knowledge, skill, habits, or action tendencies" (Gagné, 1971, p. 1). Based on the learning domains, the learning objectives could be developed.

Learning in different domains requires different mental processes and activities. Hence, the instructional method would differ according to the domain of learning (Smith & Ragan, 2005). In this study, the focus will be on developing intellectual skills. Although intellectual skills are important for students to be life-long learners, there does not seem to be any research to assist instructors to develop intellectual skills among students using technology. Hence, this research seeks to develop a framework for teaching intellectual skills for graduates.

Intellectual skills are identified as procedural knowledge or "knowing how" a learner interacts with symbols like classifying things, applying rules and principles, and solving problems (Gagné, Wager, Golas, & Keller, 2005; Gagné, 1984; Khalil & Elkhider, 2016; Smith & Ragan, 2005). Gagné emphasizes the need to distinguish intellectual skills from verbal information (recalling and stating definitions). Intellectual skills require the subskills of discrimination as well as forming and defining concepts, rules, and higher order rules. These skills must be mastered before learning more complex skills (Gagné, 1977).

Intellectual skills could be compared to four highest levels of Bloom's taxonomy of learning: application (of concepts and rules), analysis, synthesis, and evaluation, indicating higher order thinking (Driscoll, 2005). In relation to the first principles of instruction, intellectual skills are the "kind-of" component skills, which comprises of classes, categories of objects, symbols, or events to be used to solve complex problems (Merrill, 2013).

Bloom's and Gagné's taxonomies differ. The cognitive processes in Bloom's are matched to a specific knowledge level while intellectual skills are a learning domain in Gagné's. Gagné also uses problem-solving (higher levels of cognitive processes in intellectual skills) to design students activities and assessment, which are classified in the levels of analyze, evaluate and create in Bloom's taxonomy (Duan, 2006). Gagné's taxonomy is superior to Bloom's as it considers the learning condition: internal conditions which the students has prior to the instruction and external conditions such as instructions given to the students (Dick et al., 2014; Khadjooi, Rostami, & Ishaq, 2011).

In this study, Gagné's taxonomy was used because different domains of learning require a different type of mental processing and activities to achieve the outcomes. This will help instructors to better understand the type of learning expected from the students (Bloom, 1956; Krathwohl et al., 1964).

2.4 Merrill's Principles of Instruction

In this study, an eclectic instructional design model known as the First Principles of Instruction (Merrill, 2013) was used to develop the framework. The first principles of instruction is a prescriptive instructional design principle which incorporates various design theories and models (Merrill, 2002, 2013). The principles promote more effective, efficient, or engaging learning in solving real world problems, promotes learning and is a foundation for new knowledge to be applied when the learner's prior knowledge is activated. Finally learning is promoted when learners integrate new knowledge in solving a real-world problem (Merrill, 2013).

Therefore, instead of looking at how learners acquire knowledge or skills, these principles create a learning environment that is problem-centred, involving the learner in a cycle of learning that involves four distinct phases: "activation of prior experience; demonstration of skills; application of skills and integration of these skills into the real-world activities." (Merrill, 2002, p. 2). Figure 1 provides a conceptual framework relating to the first principles of instruction. This framework represents a four- phase cycle of instruction, activation, demonstration, application, and integration. This circle of instruction illustrated to be the most effective, in solving the real-world task due to the emphasizes on the problem-centred principle. Merrill believes complex tasks allows for many levels of performance.

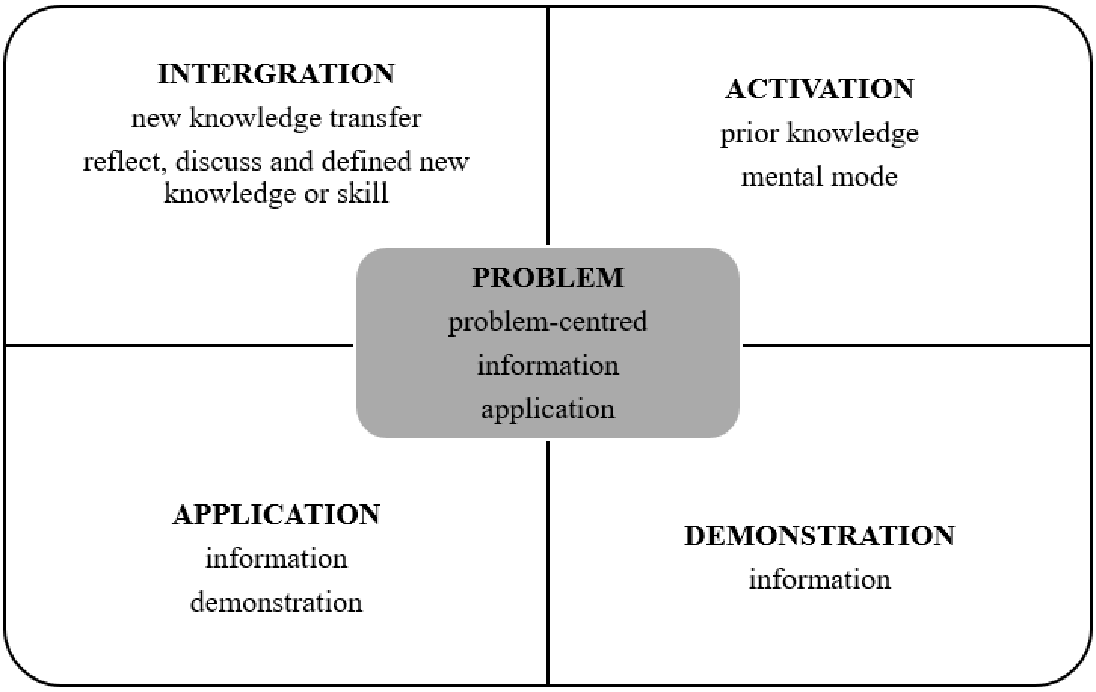

Figure 1: First principles of instruction synthesized (Merrill, 2013)

Learners may only be able to do simple tasks at first but this can be progressively more complex as the learner gains expertise (Merrill, 2006). The learning approach should be focused on collaboration to develop a framework for teaching intellectual skills based on expert's consensus. Instructors need to be aware of the CL tools that can be used to teach the 'digital natives' and design useful instructional experiences utilizing these tools to maximize students' learning. Hence, the objectives of this study are to identify the CL tool and assessment measures to develop intellectual skills using Merrill's First Principles, according to the expert's opinions.

3.0 RESEARCH DESIGN

In this section, discussion is focused on the Fuzzy Delphi Method (FDM) to obtain consensus among a panel of experts on the elements and sub-elements of instructional strategies, resources and assessment to teach intellectual skills.

3.1 Fuzzy Delphi Method (FDM)

The traditional Delphi method was a useful method for obtaining consensus (Murray, Pipino, & Gigch, 1985). The FDM was developed based on Delphi technique and improved upon as a more effective measure (Kaufmann & Gupta, 1988). Fuzzy number theory was used in group decision-making by determining the threshold value and defuzzication process (Cheng & Lin, 2002; Murray et al., 1985).

The method has been applied by researchers in developing products from various field such as sciences, engineering, curriculum, language and Islamic studies (Chang, Hsu, & Chang, 2011; Hsu, Lee, & Kreng, 2010; Jamil, Hussin, Noh, Sapar, & Alias, 2013). FDM has been used to solve problems with particular context (Jamil et al., 2013). This technique allows experts to fully express their opinions while the original opinion of the expert is retained, to ensure completeness and consistency of opinion (Jamil et al., 2013). Hence, as FDM is a well-established measure for decision-making to calculate consensus among panel of experts.

3.2 Participants

A panel of experts was selected to obtain their views and consensus on the elements required for instructional strategies, resources and assessment in order to teach intellectual skills. Experts have suggested the ideal number of experts involved in Delphi studies to vary from 10-15 (Adler & Ziglio, 1996) or 10-50 (Jones & Twiss, 1978) to maintain the high level of consistency among the panel. According to FDM, experts are a reliable resource based on their potential to evaluate and provide judgment pertaining to relevant knowledge and experience of a particular topic. Hence, the reliability of the findings would increase if more than 10 experts were involved. In this study, 16 experts were selected, after taking into consideration the availability of experts as well.

In FDM, the selection of experts ensures the reliability and validity of the data output and findings (Mustapha & Darulsalam, 2018). The experts are individuals who have academic/professional qualification, experience and are skillful in the scope of a study area because of their training, practice and exposure (Donohoe & Needham, 2009; Manakandan, Ismai, Jamil, & Ragunath, 2017; Shanteau, Weiss, Thomas, & Pounds, 2002).

Experience is prominent in expert selection. Participants with little experience, or novices and lack experience (Donohoe & Needham, 2009; Manakandan et al., 2017; Needham & Loë, 1990; Shanteau et al., 2002). Lecturers in universities and teachers for 10 to 15 years, or with experience in a related field for 4 to 7 years, are experts (Akbari & Yazdanmehr, 2014; Berliner, 2001; Leng et al., 2013; Mullen, 2003).

In this study, experts were selected based on specific criteria including academic qualification, experience, subject matter and practical knowledge in the field of practice, as follows: (a) have at least a doctoral degree qualification in educational technology and/or continuing professional development (b) were lecturers with at least ten years teaching experience (c) had academic publications in International Scientific Indexing (ISI)/SCOPUS for subject-matter expertise (d) educational technology and instructional technology experts need to have practical experience of implementing an emerging technology in teaching and learning and are being updated with current knowledge in the area. Besides that, willingness to participate in the study was another criterion. Table 1 shows the summary of the details of the panel of experts for FDM.

Table 1: Summary of the details among the expert panel

Number of experts	Position	Area of expertise	Years of Teaching Experiences
2	Professor	Educational Technology	21-40
1	Professor	Continuing Professional Education and Teacher Education	28
3	Associate Professors	Instructional Technology	24-30
1	Associate Professors	Instructional Technology; Professional and Continuing Education.	27
9	Senior Lectures	Educational Technology	15-27

3.3 The Fuzzy Delphi Method (FDM) Instrument

Firstly, a critical review of literature was conducted on use of CL tools, taxonomy of learning (intellectual skills) and the Merrill's First Principles of Instruction. Based on the theory in the field, a semi-structured interview protocol was designed to gather experts' opinions during face to face interviews on the instructional strategies, CL tools and assessment measures for developing intellectual skills. Transcripts of the interviews were analyzed to determine suitable CL tools. Data which emerged indicated tools such as video, interactive slides, animation/graphics and quiz for teaching resources for intellectual skills.

A FDM questionnaire was designed with items derived from the emergent themes. The questionnaire had a 7-point Likert scale and consisted of: Section A on experts' details, Section B regarding the experts' views on the instructional strategies based on Merrill's First Principles of Instruction, Section C on CL tools, and Section D, assessment measures. The FDM questionnaire was distributed to 16 experts.

Data obtained from the responses from the panel of experts, was analyzed based on the FDM. In this study, 16 experts were sufficient to validate the reliability of data collected. The reliability and validity of FDM findings is also increased based on a fuzzy linguistic scale where the higher the number of scales (seven-point), the more accurate and precise the data (Jamil et al., 2013; Manakandan et al., 2017; Tsai, Lee, Lee, Chen, & Liu, 2020).

4.0 DATA ANALYSIS

Firstly, the themes emerging from the semi-structured interview among the four experts was used to design the FDM questionnaire. Secondly, data collected from the questionnaire was analyzed using the FDM that focuses on the triangular fuzzy number and defuzzification process.

The four steps in the FDM adopted are according to Jamil et al. (2013). Step 1 was the selection of the linguistic variable. In this study, seven-point linguistic scale (Table 2) was selected because the higher the number of scales, the more accurate and precise the data (Jamil et al., 2013).

Table 2: Seven-Point scale of linguistic variable

Linguistic variable	Fuzzy scale
very strongly disagree	(0.0, 0.0, 0.1)
strongly disagree	(0.0, 0.1, 0.3)
disagree	(0.1, 0.3, 0.5)
not sure	(0.3, 0.5, 0.7)
agree	(0.5, 0.7, 0.9)
strongly agree	(0.7, 0.9, 1.0)
very strongly agree	(0.9, 1.0, 1.0)

Step 2 involves triangular fuzzy numbers that was used to calculate the average value which involves the minimum, the most reasonable value and the maximum value of mean (m1, m2, m3). Next is determining the threshold value 'd'. Expert consensus was reached when the threshold value less than 0.2 ($d< 0.2$) or 75% and above with 75% being the median threshold to define consensus (Adler & Ziglio, 1996; Diamond et al., 2014). There is consensus among the panel of experts if the consensus is at least 75%, if not, the FDM survey should be repeated (Cheng & Lin, 2002; Jamil et al., 2013).

Finally, the defuzzication value is calculated using a mathematical formula to determine the ranking of each variable and sub variable. The defuzzification value (DV) uses the following equation: $DV=1/3* (m1 +m2 +m3)$. Ranking is to determine the elements that are important for teaching intellectual skills. Elements with highest DV is consider important and given priority to be included in the framework.

5.0 FINDINGS AND DISCUSSION

In this section, the consensus from the sixteen experts using the FDM is reported and discussed from the aspect of **instructional strategies, CL tools and assessment measures.**

5.1 Instructional Strategies for Developing Intellectual Skills

The instructional strategies (Items 1 to 4) for teaching intellectual skills were accepted by the experts (see Table 3). No ranking was required for First Principles of Instruction since the phases were arranged accordingly.

Table 3: Instructional strategies, CL tools and assessment for developing intellectual skills

Item	Instructional Strategies	Fuzzy evaluation			Defuzzification value	Ranking
1.	**Activation**: giving students video and graphic diagram to gain their attention and to recall prior knowledge.	0.813	0.813	0.813	0.813	Not Applicable
2.	**Demonstration:** showing interactive slides, video, existing blogs and podcast to present the content	0.800	0.800	0.800	0.800	
3.	**Application:** student apply new knowledge by participating in an online discussion forum, chat	0.788	0.788	0.788	0.788	
4.	**Integration:** students know 'how to do' by applying intellectual skills into personal contexts by developing content/product	0.825	0.825	0.825	0.825	
	CL Tools	**Fuzzy evaluation**			**Defuzzification value**	**Ranking**
1.	videos	0.788	0.788	0.788	0.788	1
2.	interactive slides (visual, text, audio)	0.788	0.788	0.788	0.788	1
3.	animation/graphics	0.775	0.775	0.775	0.775	2
4.	quiz	0.738	0.738	0.738	0.738	3
	Assessment	**Fuzzy evaluation**			**Defuzzification value**	**Ranking**
1.	give problem/task for students to develop content in form of video, infographic posters, interactive slides	0.813	0.813	0.813	0.813	1
2.	give problem/task for students to design	0.775	0.775	0.775	0.775	2

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	products based on principles

Note: Condition to be met: Triangular Fuzzy Number: Threshold value *(d)*≤ 0.2Percentages of expert consensus ≥ 75%

These findings were used as a guideline to develop a framework to teach intellectual skills in a HEI. Experts agreed that emphasis should be given to intellectual skills to develop higher order thinking skills. This allows students to use problem-solving skills and knowledge construction, rather than learning facts and concepts as content (DeWitt et al., 2015; DeWitt & Koh, 2020; Ronen & Pasher, 2011).

5.2 CL Tools for Developing Intellectual Skills

The experts agreed that resources for teaching intellectual skills are video and interactive slides (DV = 0.788), followed by animation/graphics (DV= 0.775) and quizzes (DV = 0.738) (see Table 3). Videos enable connections to be made with declarative knowledge which is important for teaching procedural knowledge (Hong, Pi, & Yang, 2016). Also, students are able to practice the skills learned in the videos for learning procedural knowledge (Anderson, 2005; Hong et al., 2016). Video assisted teaching has been shown to develop self confidence among students as they are able to learn effectively with minimum or no guidance from instructors (İsmailoğlu, Orkun, Eşer, & Zaybak, 2020).

There are many open source platforms (eg. *YouTube, Vplayed, Kaltura, Panopto*) available for instructors to download videos related to their content area. However, in order to make it more interactive, instructors could redesign the video using tools such as *Nearpod* and *Edpuzzle*, to include questions at intervals to promote interactivity and engagement. Further, educational video with “pop-up” questions seem to improve students’ test performance when they were tested at the level of comprehension (classify, describe, explain, discuss) on a specific concept (Cummins, Beresford, & Rice, 2016; Haagsman, Scager, Boonstra, & Koster, 2020).

Videos incorporated at the beginning of the lesson (activation phase) enabled recall of prior knowledge so that instructors prepared students by having a mental model to connect the new knowledge with their existing knowledge. This supports students learning and assist with grasping difficult content (Hussain, Al-Mannai, Diab, & Agouni, 2020). Similarly, interactive slides can be used to present new knowledge. Applications such as *Nearpod, Microsoft Sway, Screencast-O-Matic, Loom, Screencastify, Canva, Prezi, Adobe Spark,* and *Emaze* create great options for instructors to create lessons interactive elements such as video, audio, and embedded assessments. Hence, interactive slides with graphics for presenting a lesson is an effective strategy for students interact with peers, brainstorm or complete a compare-and-contrast matrix, as compared with a content-based approach using a PowerPoint presentation (Ponce et al., 2018).

Animation such as *Animoto, Powtoon* and *Vyond* can increase students' engagement and motivation in learning activities (Hadjerrouit, 2017). Simulation and experiments done using animation software make learning abstract concepts, easier and promote thinking skills as compared to confusing text and drawings on the board (Yakob, Saiman, Sofiyan, Sari, & El Islami, 2020). Animation also facilitates procedural learning (rule learning) through creative and realistic presentation of content for learning instead of static illustrations (Lehmann et al., 2019).

Online applications to develop quizzes such as *Quizlet, Socrative, Kahoot,* and *Quiz Maker* are useful and can be embedded in the lesson. The advantage of online quizzes is that it immediately corrects misconceptions and assists problem solving (Gamage, Ayres, Behrend, & Smith, 2019; Wallihan et al., 2018). Quizzes integrated with interactive videos also increase student achievement by giving students the chance to view examples and evaluate scenarios (Gamage et al., 2019). In addition, quiz when carefully designed using various resources such as embedded videos, allow students to see real-life situations as part of problem-solving and learn concepts and rules (Gamage et al., 2019). Instructors who develop quizzes, activate students' mental models to enable recall of prior knowledge by using video-enhanced explanations of problems and feedback (West & Turner, 2016).

5.3 Assessment for Developing Intellectual Skills

The experts agreed that the most important assessment for intellectual skills are problem-solving tasks and students developing content in form of video, infographic posters, interactive slides (DV= 0.813). This is followed by problem–tasks for students to design products (DV = 0.775) (see Table 3).

Student-developed content in form of video, infographic posters, interactive slides and student-designed products as assessment enhance learning in higher education as emphasis is not on knowledge transmission but on higher level thinking to solve problems (DeWitt et al., 2015; DeWitt & Koh, 2020). Students also can apply intellectual skills into personal contexts through content curation using Wikis, video development tools and infographic tool. This facilitates collaborative knowledge construction, to promote reflective and critical thinking where students can share, learn build knowledge collectively form their peers, thus promotes promote higher-order thinking skills such as, reflective and critical thinking (Gašević, Adesope, Joksimović, & Kovanović, 2015; Hew & Cheung, 2013; Kent, Laslo, & Rafaeli, 2016; Özçinar, 2015; Ross, Dlungwane, & Van Wyk, 2019)

5.4 Framework for Developing Intellectual Skills

A problem-centered learning environment can be used as a framework. The four distinct phases are: activation of prior experience; demonstration of skills; application of skills and integration of these skills into the real-world activities (Merrill, 2013). The lesson is centered on an authentic, intriguing problem as learning is promoted when learners are engaged in solving real-world problems (Merrill, 2013).

Learning is facilitated when relevant previous experience is activated by gaining the students attention (Merrill, 2013). Activities that engage students, thought-provoking questions or hinge question using quizzes (*Socrative* and *Quizlet*) and video presentations are effective (Çetin & Solmaz, 2020; Seel et al., 2017). In addition, content presented using videos or graphics that provoke students' curiosity or students creating their own videos using *Edpuzzle*,*Nearpod* and *Flipgrid* to answer questions posed by others may be useful (Çetin & Solmaz, 2020). Hence, stimulating recall of prior knowledge enables students' mental model to be activated by relating to previous experiences the current knowledge being taught (Jeong, 2019; Miner et al., 2015).

Learning is facilitated when instructors demonstrate new knowledge that is to be learned rather than telling information about what is to be learned (Merrill, 2013). Presenting new information using multiple methods (eg. videos, screen casting podcasts, group work using variety of multimedia elements) (Goh & Kale, 2015; Vasodavan, Dewitt, & Alias, 2019), and providing examples and organizing information in small chunks, makes learning easier and reduces load on working memory (Norris, Kalm, & Hall, 2020; Thalmann, Souza, & Oberauer, 2019). Hence, instructors should provide continuous learning guidance and scaffolding which can be withdrawn gradually as students masters the skills or knowledge (Dick et al., 2014; Merrill, 2013). Tools such as concept mapping, role playing and visualizing assists students in developing intellectual skills (Dias, Hadjileontiadou, Diniz, & Hadjileontiadis, 2017; Ponce et al., 2018).

Students apply the new knowledge or skills learnt to solve problems in the application phase (Merrill, 2013). Students' learning is reinforced and they are assured that the new knowledge generated is correct (Dick et al., 2014; Merrill, 2013). Allowing students to demonstrate the newly acquired knowledge allows them to internalize new skills and knowledge (Belland, 2016). Instructors can pose questions in discussion forums so that students can share their knowledge by elaborating their own arguments or concepts (Kent et al., 2016; Tibi, 2018). This creates opportunities for students to compare and synthesize multiple perspectives from their peers (Di, Ranieri, & Bruni, 2019; Xie, 2013).

The integration phase requires students to transfer or internalize the new knowledge or skills in their everyday life (Merrill, 2013). This happens when they apply intellectual skills into personal contexts. For example, by using infographic tools such as Canva for converting information learned into different format is an effective way of retaining information to be used effectively in future (DeWitt & Alias, 2017).

Challenging tasks such as developing content in form of videos, infographic posters, interactive slides or designing products based on principles shows students' progress and increases their sense of ownership (Huang, 2015; Peterson & Roseth, 2015; Roberts, 2015). Ideally, before implementing this framework for developing intellectual skills, instructors should identify the course aim and learning objectives. This framework can be used across discipline and students' knowledge level. The framework for teaching intellectual skills is illustrated in Figure 2.

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INTERGRATION

Learning is promoted when new knowledge **(classifying things, concept, applying rules and principles, and solving problems)** is integrated when students know how to do something apply intellectual skills into personal contexts. Instructors can:

- ✓ give problem/task for students to develop content in form of video, infographic posters, interactive slides
- ✓ give problem/task for students to design products based on principles

- Collaborative Tools: *(e.g. Wikis, video development tools, infographic tool-Canva)*

ACTIVATION

Learning is promoted when student's prior knowledge is activated as a foundation for new knowledge **(classifying things, concept, applying rules and principles, and solving problems)**
e.g. giving students video and graphic diagram to gain their attention and to recall prior knowledge.

- Collaborative Tools: (e.g. *YouTube, Screencast, Mind Maps)*

PROBLEM TASK CENTRED
Instructors should provide real world problem that the students will be able to engage in.

APPLICATION

Learning is promoted when new knowledge **(classifying things, concept, applying rules and principles, and solving problems)** is applied by the students to solve new problems.
e.g. student apply new knowledge by participating in an online discussion forum, chat
Collaborative Tools: *(e.g. LMS discussion forum/chat/WhatsApp, Facebook)*

DEMONSTRATION

Learning is promoted when new knowledge **(classifying things, concept, applying rules and principles, and solving problems)** is demonstrated by instructors to the students
e.g. showing *interactive slides, video, existing blogs and podcast* to present the content

- Collaborative Tools: *(*e.g. *Prezi, Screencast, YouTube, Blogger)*

Figure 2: Framework of developing intellectual skills with Merrill's' first principle of instruction

6.0 CONCLUSION

In this study, different CL tools are needed to teach intellectual skills such as classifying things, concept, applying rules and principles, and solving problems. This guides HEIs on the instructional strategies, CL tools and assessment for developing intellectual skills specific for the twenty-first century. This framework could be use as reference by instructors to equip themselves with the technology skills and knowledge on specific CL tools for innovative pedagogy. The framework could be implemented and applied across any discipline and field of study. However, instructors need to incorporate technology with pedagogy and content knowledge.

This framework promotes a culture of innovation in technology-use. Activities should be planned for skills, knowledge, and information in solving real world problems. Emphasis is on knowledge building and meaning making instead absorbing information. Students will benefit as the CL tasks and activities allow them to work in teams to interact, apply, evaluate, create new knowledge and problem solving. These collaborative skills will be useful in the work environment. At the same time, when instructors move away from teacher-centered approaches and focus on discussions, debates, argumentation, and deep understanding, this promotes joint construction of knowledge among students (Herrera-Pavo, 2020). That means that students will benefit by becoming responsible for their learning while using CL tools. Finally, the framework offers practical application for instructors to demonstrate and plan their lessons by referring to Frist Principle of Instruction.

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